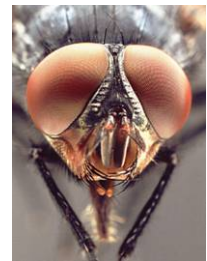# Pamela Abshire, Ph.D.

Director, Integrated Biomorphic Information Systems Lab
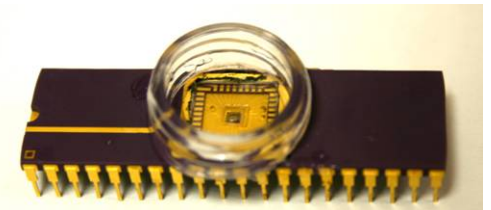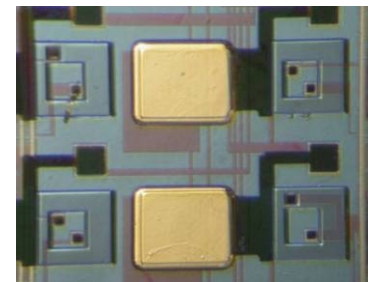Institute for Systems Research
Department of Electrical and Computer Engineering
University of Maryland, College Park

Relevant research

- Bio-electronic interfaces
  - cell clinics: bio-MEMS-VLSI system
  - spike sorter: integrated signal processing

- Biomorphic hardware
  - adaptive circuits
  - fly vision

- Advanced packaging for bio-integration

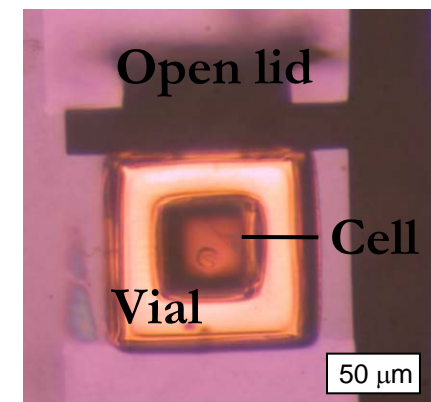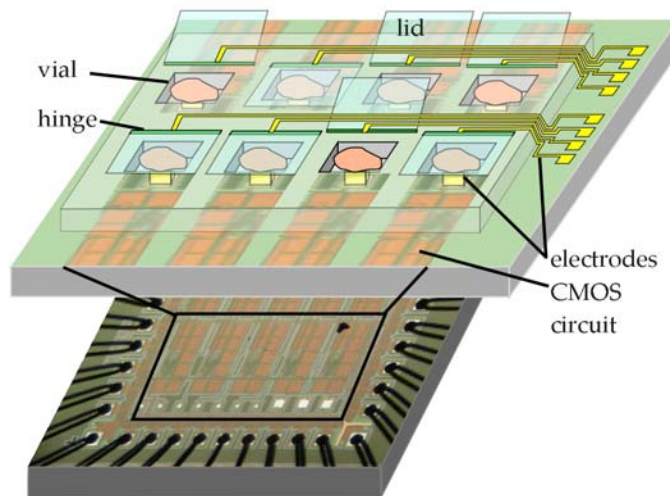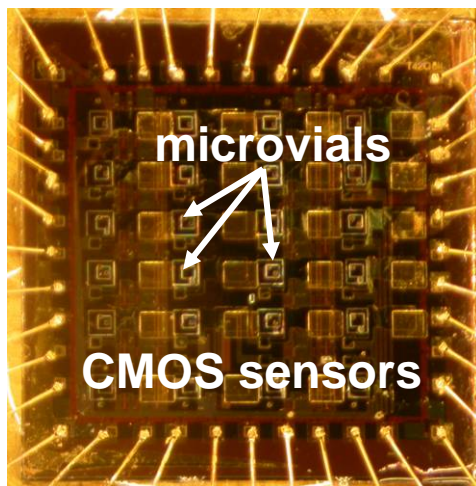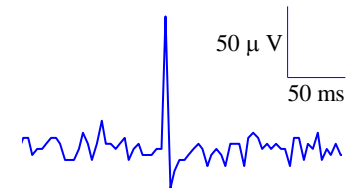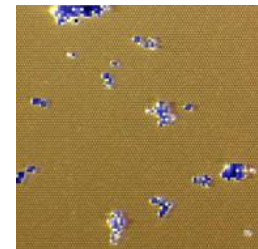Contact information: (301)405-6629, pabshire@umd.edu

Cell Clinics: Platform for Cell-based sensing

MEMS on CMOS circuits and sensors for *in situ*, real time sensing of cultured cells.

Collaboration with Elisabeth Smela, UMCP

- Microfabricated vials with hinged lids controlled by Ppy/Au bilayer microactuators.
- IC sensors for: extracellular electrical activity, cell adhesion & viability, position, fluorescence.

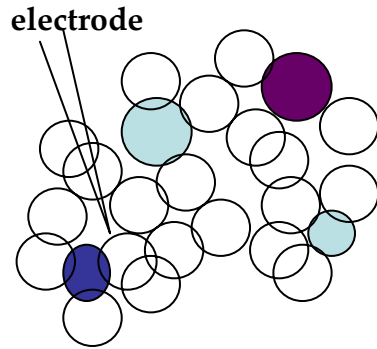Applications in olfaction, low-false-positive pathogen detection, cell pathway monitoring.

50 µ V

50 ms

microvials

CMOS sensors

lid

vial

hinge

electrodes
CMOS
circuit

Open lid

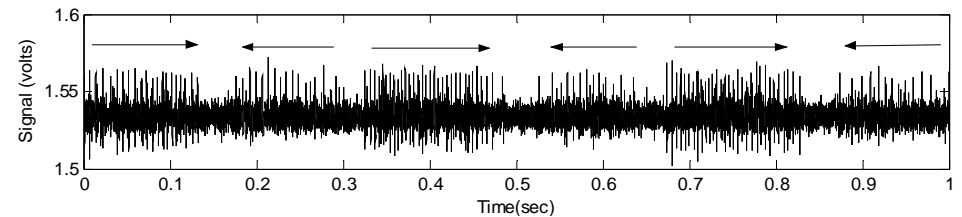Cell

Vial

50 µm

pabshire@umd.edu
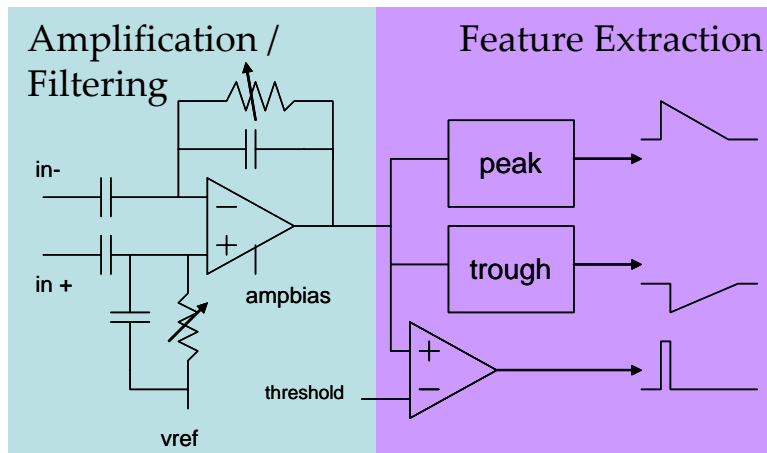
On-Chip Spike Sorting

Collaboration with Timothy Horiuchi, UMCP
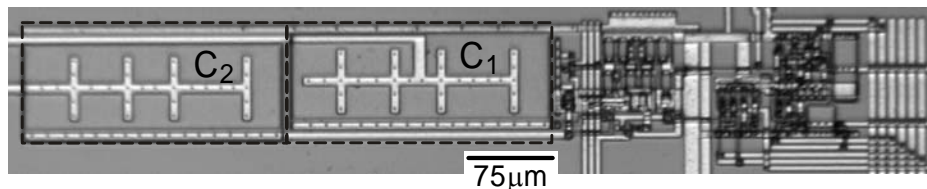
electrode

Spike Sorting is the problem of identifying **which** neuron fired **when**.
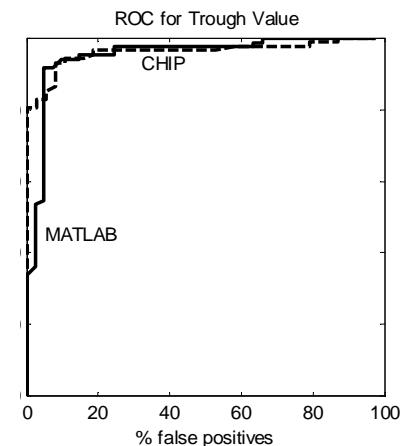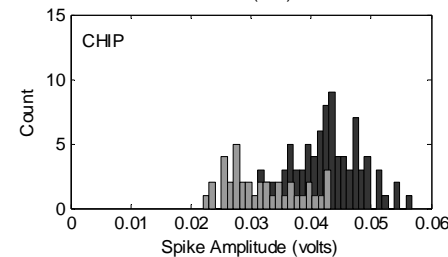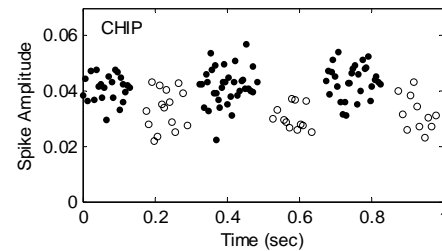
Spikes elicited in response to a visual stimulus moving in two alternating directions by wide-field motion-sensitive cells of blowfly.

Amplification / Filtering

in-

in +

ampbias

threshold

vref

Feature Extraction

peak

trough

Simple, low-power circuit for spike-sorting.

C₂   C₁

75μm

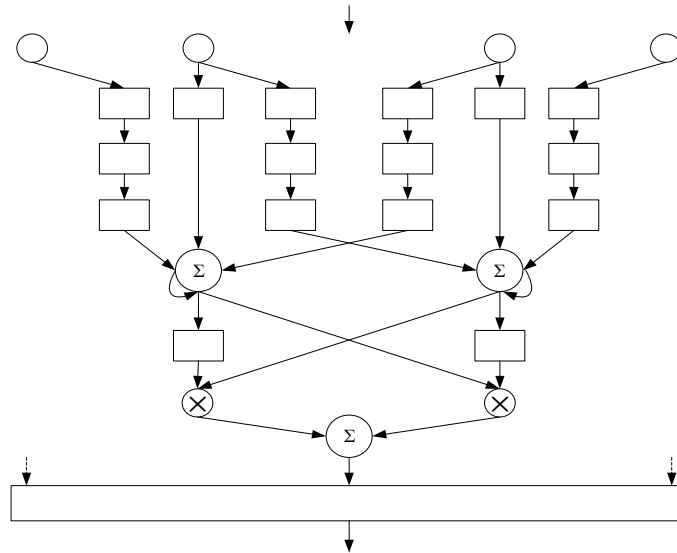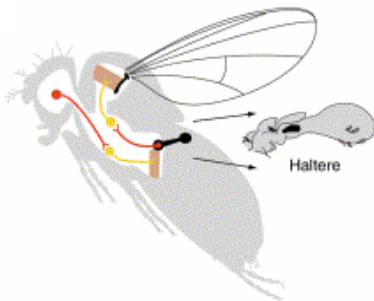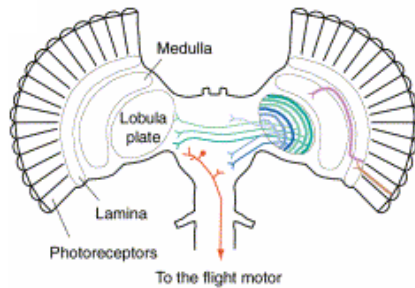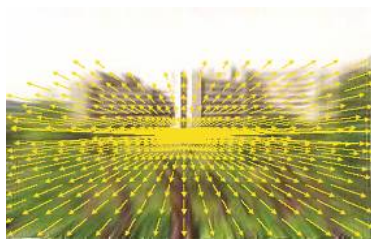Fabricated in 1.5μm process. Layout ~760μ mx120μm.

Simple features discriminate between distinct classes of neurons.

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Biomorphic fly vision

Collaboration with
Sean Humbert, UMCP

Closed loop sense/react:
visual motion detection
and flight control

Information processing
based on optic flow in
wide-field motion
sensitive cells

Fly inspired motion sensor for self motion
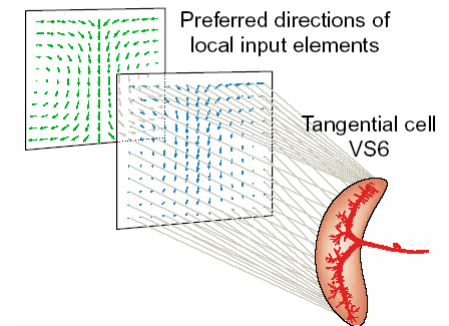estimation and small object detection

- Extended correlation-type elementary
  motion detectors
- Built in adaptation and nonlinearity for
  wide dynamic range
- Advantages: power efficiency, speed
  and robustness

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Null Direction (ND)   Preferred Direction (PD)
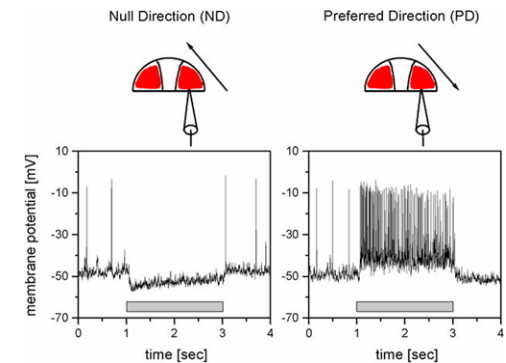
Directions of
optic flow vectors
during roll

Preferred directions of
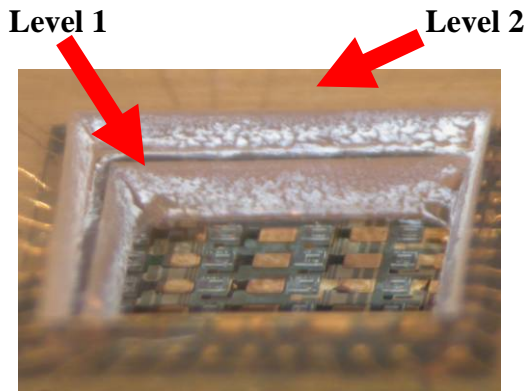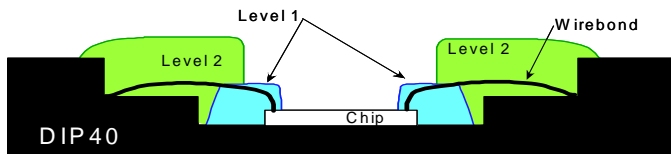local input elements

Tangential cell
VS6

M. Frye, et al. Neuron, Nov. 2001

A. Borst, et al. J. Comp Physio 2002

M. Egelhaaf, et al. TINS, Feb. 2002

P

Biocompatible packaging

Collaboration with Elisabeth Smela, UMCP

Level 1

Level 2

Wirebond

Level 2

Chip

DIP 40

Underfill

CMOS chip (1.5x1.5mm^2)

Plated vias

Surface of CMOS chip

Level 1

Level 2

Current method:
Bond wires encapsulated w/ low-swelling polymer, well holds culture medium

NEW method under development:
Back side contacts. Holes etched using DRIE, passivated, and electrolessly plated.

50µm
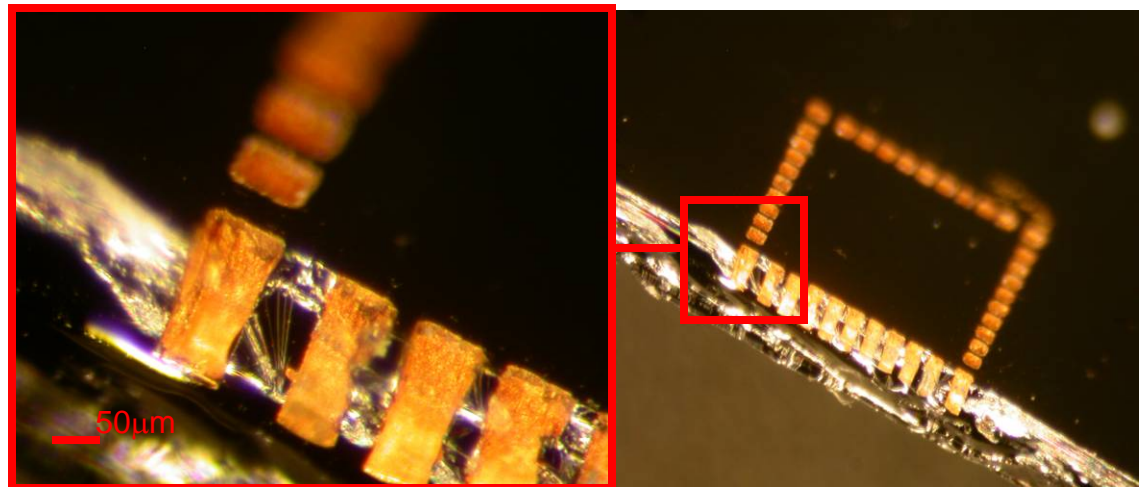
Photomicrograph of plated vias.

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